resistivity of the photoresist materials of the invention. For example, claim 18 describes a method of processing a semiconductor substrate that utilizes plasma etching for forming a selected pattern on the substrate surface following the steps of coating the substrate with a photoresist having encapsulated inorganic materials, exposing selected portions of the coated surface to an activating radiation, and removing either the radiation-exposed or unexposed portions of the photoresist composition.

Support for the above amendments can be found in the original claims, and throughout the specification. For example, on page 9, at lines 1-5, the specification recites ranges for the average particle size of the inorganic core particles utilized in a photoresist composition of the invention. These include ranges, for example, between about 1 to 50 nm, 1 and 20 nm, 1 and 10 nm, and most preferably less than 5 nm. Moreover, on page 35, at lines 13-25, and on page 37, at lines 11-15, the specification describes the plasma etch properties of a number of resists prepared in accordance with the teachings of the invention. Further, on page 29, at lines 15-20, the specification recites that an alkaline solution can be employed to remove areas of a photoresist film of the invention that have been subjected to activating radiation. Moreover, the specification recites that a wafer "masked" by a pattern of a photoresist material, such as, the photoresist materials of the invention, "can be processed to form active electronic devices and circuits by deposition of conductive or semiconductive materials or by implantation of dopants." *See* specification, page 1, lines 20-25.

The various rejections raised in the Office Action are discussed in detail below.

Rejections under 35 U.S.C. 102(b)

The Office Action rejects claims 1 and 6 as anticipated by U.S. Patent No. 5,691,101 of Ushirogouchi. As discussed below, amended claims 1 and 6 distinguish patentably over this reference.

Ushirogouchi is directed to photosensitive compositions that can be utilized for image formation, for example, in a display device or an image pickup device. In one embodiment, Ushirogouchi describes a photo-sensitive composition that contains a compound that generates

an acid when irradiated with light or ionizing radiation, a resin with acid-crosslinkability or acid-decomposability, and a powder having particles with an average size of 100 microns or less. The exemplary average particle sizes listed in the examples provided in Ushirogouchi range from 0.1 micron to 3 microns. The powder is utilized to improve the heat resistance and/or the strength of the photosensitive composition.

Unlike the claimed invention, Ushirogouchi does not teach photoresist compositions for wafer processing. Rather, it describes photosensitive compositions that can be utilized for image formation in a display device or an image pick-up device. Further, the average particle size of the powder utilized in Ushirogouchi's photosensitive composition, i.e., in a range of 0.1 to 3 microns, is substantially larger than the average size of less than 10 nm, recited in amended claim 1, for the core particles of the encapsulated inorganic materials in a photoresist of the invention.

Hence, the photosensitive composition of Ushirogouchi does not provide the functionality and the advantages of the photoresist compositions of the invention. For example, Applicant explains that the small molecular size of the core particles of a photoresist composition of the invention "allows development of high resolution systems with a relatively small molecular pixel size of less than 10 nm." Moreover, "particle dispersions comprised of this small molecular size behave for all intents and purposes as a solution and allow conventional resist processing." *See* specification, page 10, lines 5-8. In contrast, Ushirogouchi lacks any teaching or suggestion, or any hint of recognition, regarding selecting the range of particle sizes taught by the present invention that lead to distinct advantages in photoresist materials to be utilized, *inter alia*, for wafer processing.

Accordingly, amended claim 1, and claims 2-14 depedent thereon, distinguish patentably over Ushigouchi.

Amended claim 15 recites a positive photoresist composition that includes encapsulated inorganic material with core particles having an average size ranging from about 1 nm to about 50 nm, and is base-soluble upon activation by radiation. Ushirogouchi does not teach the combined features of base-solubility and an inorganic constituent material with particle sizes

ranging from about 1nm to 50 nm, recited in claim 15. Accordingly, similar to independent amended claim 1, amended claim 15 is also patentable over the Ushirogouchi.

New independent claims 18, 20, and 21 relate to methods of processing/patterning a semiconductor surface by coating the surface with a photoresist composition according to the teachings of the invention, patterning the coating, for example, through exposure to an activating radiation, removing either the exposed or unexposed portions, and plasma-etching the portions of the surface from which the coating is removed, or implanting a dose of an ion in these portions.

As discussed above, Ushirogouchi is directed to water-soluble photosensitive compositions that can be utilized for image formation. Ushirogouchi, however, does not teach plasma-etching a substrate surface on which a patterned coating of a photoresist composition is formed, as recited in claims 18 and 21. Nor does it teach implanting ions in such a substrate, as recited in claim 20. Accordingly, these claims distinguish patentably over Ushirogouchi.

In paragraph 3, the Office Action rejects claims 1, 6, 9-11, and 14 as being anticipated by U.S. Patent No. 3,660,097 of Mainthia that describes light-sensitive resinous compositions that can be utilized in lithographic printing. More particularly, Manthia describes light-sensitive polyurethane compositions suitable for coating a lithographic printing plate for forming an image thereon. The compositions of Mainthia can include a solvent-soluble, negative-acting or positive-acting, light-sensitive diazonium component and a polyurethane resin compound. In addition, the compositions can include reinforcing fillers, for example, synthetic silicas, for increased strength and improved surface appearance.

Mainthia does not teach or suggest employing a particular range of sizes for the silica particles. More particularly, there is no teaching in Mainthia regarding the advantages of resist compositions having average encapsulated particle sizes less than about 10 nanameters, as recited in amended claim 1. In addition, there is no teaching or suggestion in Mainthia regarding a photosensitive composition that is base-soluble when subjected to an activating radiation, and further includes an inorganic material having core particles with an average size ranging from about 1 nm to about 50 nm, as recited in amended claim 15. Thus, Mainthia does not teach material features of these claims and the advantages that these features provide. Hence,

independent amended claims 1 and 15, and claims dependent thereon, distinguish patentably over Mainthia.

Further, the same arguments as those provided above with respect to new methods claims 18, 20, and 21 apply with equal force to establish that these claims also distinguish patentably over Mainthia.

In paragraph 4, the Office Action rejects claims 1 and 6 as being anticipated by U.S. Patent No. 6,190,825 of Denzinger that describes a positive or negative-working radiation-sensitive mixture having a polymeric binder and at least one radiation-sensitive compound. In one of the examples provided in Denzinger, the radiation-sensitive mixture further includes a silica gel filler having a mean particle size of 4 microns. Denzinger states that the radiation-sensitive compound can be utilized for the production of chemical-resistant relief recordings.

The mean particle size of the silica gel utilized in one exemplary embodiment of the radiation-sensitive mixture of Denzinger is substantially larger than the average size recited for the core particles of an inorganic material employed as one constituent of a photo-sensitive resist composition of the invention. More particularly, whereas the mean particle size recited by Denzinger is 4 microns, amended claim 1 recites an average particle size less than 10 nanometers, and amended claim 15 recites an average particle size ranging from about 1 nm to about 50 nm. Accordingly, Denzinger does not teach material features of these claims and their concomitant advantages. Hence, these claims, and claims depending thereon, are patentable over Denzinger. Further, Denzinger does not teach or suggest utilizing plasma-etching or ion implantation of a semiconductor surface on which a patterned photoresist composition is deposited. Accordingly, similar to claims 1 and 15, independent method claims 18, 20, and 21 are also patentable over Denzinger.

In Paragarph 5, the Office Action rejects claims 1, 5, 6, 9, 10, 12, and 13 as being anticipated by U.S. Patent No. 5,998,084 of Elsaesser that describes a positive-working radiation sensitive recording material suitable for the production of planographic printing plates. More particularly, Elsaesser describes a radiation-sensitive layer that can include a polycondensate having phenolic groups, a binder resin, a vinyl type polymer, a clathrate-forming compound, a

low molecular weight compound having at least one acidic hydrogen atom, and silica gel particles. The silica gel particles have a mean grain size in a range of 3 to 5 microns.

The average size of 3 to 5 microns of the silica gel particles utilized in the recording material of Elsaesser is significantly larger than the average size of less than 10 nm, or an average size in a range of 1 to 50 nm, recited in amended claims 1 and 15, respectively. Hence, Elsaesser does not teach or suggest the compositional features of the photoresist materials of the invention, and their concomitant functionality and advantages. In addition, the radiation sensitive materials of Elsaesser are employed for the production of planographic printing plates, and not for semiconductor processing that can include plasma-etching and/or ion implantation steps, as recited in independent method claims 18, 20, and 21. Accordingly, similar to amended claims 1 and 15, these method claims are also patentable over Elsaesser.

<u>Rejections Under 35 U.S.C. 103</u>

The Office Action rejects claims 1-14 as being unpatentable over U.S. Patent No. 5,942,369 of Ota. The claims presently pending in the application distinguish patentably over Ota at least for the reasons discussed below.

Ota describes a positive photoresist composition that includes a Novolak resin, a alkali-soluble acrylic resin, a quinonediazide group-containing compound, and a solvent. Further, a filler, such as, silica or alumina, can also be optionally added to the photoresist composition. The filler is utilized to modify the viscosity of the photoresist composition.

Ota does not teach or suggest utilizing silica or alumina particles with an average particle size less than about 10 nm, as recited in claim 1, or in a range of about 1 to 50 nm, as recited in claim 15. In fact, there is no recognition in Ota regarding selecting the particles to have an average size in ranges taught by the claimed invention, and hence no teachings regarding photoresists having the properties of the compositions of the invention. In fact, the purpose of adding silica or alumina to the photoresist composition in Ota is to modify the viscosity of the composition. In contrast, in the claimed invention, the inorganic materials having core particles are employed to provide resist materials that exhibit, among other useful properties, an increased plasma etch selectivity. Moreover, Ota does not teach or suggest plasma-etching of a substrate

Clean Copy of Amended and New Claims

A1 Sub B1

1.(Amended) A positive photosensitive resist composition comprising a resin binder and an encapsulated inorganic material comprising core particles having an average size less than about 10 nanometers.

A2

15.(Amended) A positive photosensitive resist composition comprising a resin binder and an encapsulated inorganic material comprising core particles having an average size ranging from about 1 nm to about 50 nm, wherein the photoresist is base soluble upon activation by radiation.

A3

18. (New) A method of processing a semiconductor substrate, comprising:

coating the substrate surface with a photosensitive resist composition having a resin binder and an encapsulated inorganic material including core particles,

exposing selected portions of the coated surface to an activating radiation to cause a chemical transformation in the exposed portions,

removing either the radiation-exposed or unexposed portions of the photoresist composition, and

plasma-etching the substrate surface to generate a pattern thereon.

19.(New) A method according to claim 18, further comprising selecting the core particles to have an average size less than about 10 nanometers.

20.(New) A method of processing a semiconductor substrate, comprising:

coating the substrate surface with a photosensitive resist composition having a resin binder and an encapsulated inorganic material including core particles,

exposing selected portions of the coated surface to an activating radiation to cause a chemical transformation in the exposed portions,

removing either the radiation-exposed or unexposed portions of the resist composition, and

exposing the substrate surface to an ion beam to implant a selected dose of the ion in the portions of the substrate from which the photoresist coating is removed.

21.(New) A method of patterning a semiconductor surface, comprising:

coating the substrate surface with a base-soluble photosensitive resist composition having a resin binder and an encapsulated inorganic material comprising core particles with an average size ranging from about 1 nm to about 50 nm,

exposing selected portions of the coated surface to an activating radiation to cause a chemical transformation in the exposed portions,

removing either the radiation exposed or unexposed portions of the resist composition, and

plasma-etching the substrate surface to generated a pattern thereon.

surface coated with a patterned photoresist composition, as recited in claims 18 and 21. Nor does it teach implanting ions in such a coated substrate surface, as recited in claim 20.

Thus, the claims presently pending in the application distinguish patentably over the teachings of Ota.

In Paragraph 8, the Office Action rejects claims 1-17 as being obvious in view of U.S. Patent No. 6,114,083 of Kawamura. This patent is directed to a radiation-sensitive planographic printing plate that includes a photosensitive layer which contains, *inter alia*, water-insoluble particles, with an average size larger than 10 nanometers, and more preferably, in a range from 0.1 to 5 microns.

Kawaruma does not teach an average particle size less than about 10 nm, as recited in claim 1. Further, Kawaruma does not teach or suggest a photoresist composition that, in addition to having particles with an average size between 1 to 50 nm, is base-soluble upon activation by radiation. In fact, the photoresist composition of Kawaruma is not even water-soluble. Thus, amended claims 1 and 15, and those claims depending thereon, distinguish patentably over Kawaruma. Further, the same arguments as those presented above with respect to independent method claims 18, 20, and 21 apply to establish that these claims are patentable over the teachings of Kawaruma.

CONCLUSION

In view of the above amendments and remarks, Applicant respectfully requests reconsideration and allowance of the application with claims 1-21 pending therein. If there are any remaining issues, Applicant invites the Examiner to call the undersigned at 617-439-2514.

Dated: November 27, 2001

Respectfully submitted,

By

Reza Mollaaghababa
Registration No.: 43,810
NUTTER MCCLENNEN & FISH LLP
One International Place
Boston, Massachusetts 02110-2699
(617) 439-2514
Attorneys for Applicant

Docket No. 101328-0148

Application No. 09/512,942

Amended Claims With Revisions Marked

1. (Amended) A positive photosensitive resist composition comprising a resin binder and an encapsulated inorganic material comprising core particles having an average size less than about 10 nanometers.

15. (Amended) [The] A positive photosensitive resist composition [of claim 1, wherein] comprising a resin binder and [the] an encapsulated inorganic material [further comprises] comprising core particles having an average size ranging from about 1 nm to about 50 nm, wherein the photosensitive resist is base soluble upon activation by radiation.

18. (New) A method of processing a semiconductor substrate, comprising:

coating the substrate surface with a photosensitive resist composition having a resin binder and an encapsulated inorganic material including core particles,

exposing selected portions of the coated surface to an activating radiation to cause a chemical transformation in the exposed portions,

removing either the radiation-exposed or unexposed portions of the photoresist composition, and

plasma etching the substrate surface to generate a selected pattern thereon.

19. (New) A method according to claim 18, further comprising selecting the core particles to have an average size less than about 10 nanometers.

20. (New) A method of processing a semiconductor substrate, comprising:

coating the substrate surface with a photosensitive resist composition having a resin binder and an encapsulated inorganic material including core particles,

exposing selected portions of the coated surface to an activating radiation to cause a chemical transformation in the exposed portions,

removing either the radiation-exposed or unexposed portions of the resist composition, and

exposing the substrate surface to an ion beam to implant a selected dose of the ion in portions of the substrate from which the photoresist coating is removed.

21. (New) A method of patterning a semiconductor surface, comprising:

coating the substrate surface with a base-soluble photosensitive resist composition having a resin binder and an encapsulated inorganic material comprising core particles with an average size ranging from about 1 nm to about 50 nm,

exposing selected portions of the coated surface to an activating radiation to cause a chemical transformation in the exposed portions,

removing either the radiation exposed or unexposed portions of the resist composition,

plasma etching the substrate surface to generate a pattern thereon.

1044639.1